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REVIEW

Pallas's Gull Ichthyaetus ichthyaetus and Fish Farming of the Palearctic: Review

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ABSTRACT

The Pallas's Gull *Ichthyaetus ichthyaetus* is a piscivorous predator and scavenger, some breeding populations of which are vulnerable and require protection. This study analyzes the status and distribution of Pallas's Gull in Palearctic fish ponds—man–made bodies of water where fish concentrations are controlled by humans and can be many times higher than natural values. The aim of the study was to assess the state of the Pallas's Gull in the fish farming of the Palearctic over the last ≈ 60 years. The review was based on > 1100 publications found in the search engines Yandex, Google, Google Scholar, eLybrary. Between the 1960s and 2020s, the Pallas's Gull was discovered in 46 fish farms in the Palearctic. Breeding has been established in 3 fish farms, breeding has not been established in 38 fish farms, and birds were present in 5 fish farms, but the status was not specified. There were 35 places of contact with fish farms in Europe, and 11 places of contact in Asia. The average area of fish farms with which Pallas's Gull came into contact was 10.7 km² (n = 21). Fish farms support non–breeding individuals — vagrants, visitors, summer or winter residents of different age classes. Fish farms cannot be considered as important places for the reproduction of the species. The network of fish farms plays a certain auxiliary, but far from decisive role in maintaining the population and the current multidirectional expansion of the species' range in the Palearctic. The hypothesis about the possible important role of reservoirs and fish farms in food supply and the distribution of Pallas's Gull beyond the historical range was not confirmed in studies of fish farms.

Keywords: Larus; Aquaculture; Hatchery; Fishing; Pond; Reservoir; Status; Conservation

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1. Introduction

The problem of the relationship between piscivorous avian predators and fish farming has a long history. The development of fish farms occurred against a backdrop of loss of biodiversity, habitat and climate change. Therefore, in the light of the conservation of vulnerable biological species, this problem remains relevant. Piscivorous bird species are highly dependent on the availability, abundance and accessibility of fish as an important food resource. The Pallas's Gull *Ichthyaetus ichthyaetus* is one such species. In search of food or potential breeding sites, these gulls explore large areas and interact with various bodies of water, including reservoirs of fish farms. Moreover, Pallas's Gulls are an object of aesthetic pleasure for humans. Therefore, understanding the interactions between Pallas's Gulls and fish farming is particularly important in the context of the conservation and management of vulnerable populations of this bird species.

There is an opinion among scientists that stocks of fish and other biological resources are rapidly declining, and in the 21st century, fishing may disappear altogether, but only aquaculture, in particular fish farming, can replenish it [1]. One of the directions of aquaculture is pond fish farming, based on the study of the production of fish as a food resource [2], whose open bodies of waters attract piscivorous avian predators and other bird species [3–6]. Fish ponds are artificial bodies of water used by humans for commercial purposes [2], as well as for breeding, growing and preserving valuable or vulnerable fish species. The importance of pond fish farming is increasing every year [2], and the need to develop this branch of food products is becoming increasingly relevant over time.

In functional terms, fish ponds are differentiated into feeding, uterine, spawning, nursery and wintering, and they can be used simultaneously, for example, for irrigation, recreation and fish farming [1]. Fish ponds in the center of the Non–Chernozem region in Russia, for example, have a flat bottom profile, good warming of the water masses and a high density of farmed fish. They are shallow and highly eutrophicated. Ponds are filled with water and stocked with juvenile fish in the spring, and water is released and fish are caught in feeding ponds in late summer and autumn [7]. Of course, fish ponds have their own characteristics in different geographic regions. However, in the bodies of water of fish farms, the concentration of fish can be many times higher than natural indicators [8], thereby attracting piscivorous predators. Fish ponds are important for dispersal piscivorous bird species and for the conservation of many other bird species, especially in regions where natural wetlands are rare [9,10]. In this regard, the Pallas's Gull is of particular interest to scientists, since it is ecologically closely related to marine and freshwater ecosystems, including artificial water bodies.

The Pallas's Gull is one of the largest gulls in the world and the largest of the group of black—headed gulls (**Figure 1**), which use fish farm bodies of water with a large number of easily accessible fish for feeding [11].

Figure 1. The Pallas's Gull (*Ichthyaetus ichthyaetus*) eating Bream (*Abramis brama*). September 17, 2022. Kuibyshev reservoir, Volga River Basin, Russia. Images: S.V. Golubev.

It is predominantly a piscivorous predator and scavenger, although in general the species is omnivorous. The nesting range of the Pallas's Gull is located exclusively in the Palearctic. Breeding occurs in colonies, rarely in separate pairs. Non–breeding individuals are capable of dispersing over considerable distances. The species is included in the least threatened category with positive population growth [11,12]. In Russia, Ukraine, Kazakhstan, Uzbekistan and Kyrgyzstan, the Pallas's Gull is included in the national Red Data Books [13] and serves as an object of monitoring.

In recent decades, special attention of ornithol-

ogists has focused on the expansion of the range of Pallas's Gull to the north, west and east [11,14]. Against this background, registration of the species continued in the territories of Palearctic fish farms both in the 20th century and at the beginning of the 21st century. However, at the beginning of the 21st century, at least in Russia, Uzbekistan, Kyrgyzstan, Belarus, Poland, the Czech Republic, Serbia and Egypt, interest in the problem at hand increased, accompanied by an increase in the number of observations [4,14–19].

Over the course of several centuries, the habitat of the Pallas's Gull in Northern Eurasia has undergone significant changes against the backdrop of climate change [20]. The transformation of relatively natural ecosystems took place without taking into account the needs of most species. Many ecosystems have, to a greater or lesser extent, experienced the modifying effects of human activity and have affected the state of the Pallas's Gull population [21]. Over time, the importance of artificial bodies of water in the life of this bird species has steadily increased. Currently, the Pallas's Gull is found in reservoirs and breeds in some of them [13,22]. In Russia, the appearance of the Pallas's Gull in the Middle Volga region may have been associated with the development of a network of fish farms and an increase in the level of the Caspian Sea [23]. These gulls visit not only fish ponds, but also ordinary ponds [24–28], where they are also able to breed [29]. In countries such as Cyprus, where there are few fish ponds, they serve as ideal winter habitats for the Pallas's Gull [9]. In Israel, from the late 1960s to early 2000, a significant increase in the number of Pallas's Gulls may have been associated with an increase in the number of open fish ponds [9,30]. The Pallas's Gull is found in technogenic bodies of water [31–35] and breeds in evaporation ponds [36]. An assessment of the growing role of artificial bodies of water in the distribution and ecology of Pallas's Gulls in the Palearctic was further developed in this study. In general, understanding of the most important aspects of the distribution of Pallas's Gull in the changing habitat of the species has not reached the required level. Moreover, the problem of interactions between fish–eating avian predators and human activities still remains unresolved, which inevitably induces conflict situations.

The expansion of the range of Pallas's Gull occurs against the backdrop of local conflicts between fish–eating birds and the fishing business. In this regard, the search for reasonable compromises and ways to optimize conflicts between the fishing industry and fish–eating predators is of particular relevance at the present time. It is known that Pallas's Gull consumption rates are estimated at 0.10–0.15 kg/day [4]. At the same time, locally it can form aggregations, dominate in abundance in bird assemblies and cause damage to the fishing industry. For example, in Egypt, the most abundant bird species present on the fish farm near El–Noras village was the Pallas's Gull, which accounted for over 57.33% of the total number of birds sighted on the farm for the entire period of observations [4]. In addition, Pallas's Gull inspects fishing nets [37–40] and is capable of damaging them, removing fish, which it also damages in the process of releasing it [41,42]. Hunting for fish and breeding of Pallas's Gulls in the territories of fish farms in some cases can result in death for these birds and their offspring.

In the fishing and fish farming industry of Ukraine and Russia, direct persecution of the Pallas's Gull by humans has been established (shooting in fish farms and during commercial fishing), as well as entanglement and death of birds, including young ones, in fishing nets [11,23,43–46]. Along with this, direct destruction of nests [27] and clutches of eggs [41] of gulls has been established in stocked bodies of water. During the breeding season, the Pallas's Gull may experience disturbance from vacationers and fishermen [41]. The above reasons clearly hinder the development of fish farm water bodies by Pallas's Gull.

On the other hand, gulls are able to benefit from interactions with fish farm water bodies. For example, on the ponds of fish farms, recreational fishing, hunting, movement on boats with or without motors, swimming may be prohibited [3] and access of unauthorized persons to the bodies of water of fish farms may be partially or completely limited [3,47,48]. Due to the abundance of bird life, the bodies of water and

surrounding areas of some fish farms, for example, Suskansky Bay of Kuybyshev Reservoir (SA–003) in Russia [49], are included in the Important Bird Areas list of international importance [50]. The Beloye fish farm in Belarus was also awarded international bird conservation status [48]. Thus, the conservation of appropriate habitats may have a positive effect on Pallas's Gulls that come into contact with fish farms. At the same time, the conservation status of some fish farms provides more guarantees for the conservation of the local bird population in these areas.

Despite the fact that the avifauna of fish farm water bodies has been studied in different geographical regions and with different levels of detail [3,5,6,51–59], many aspects of the ecology of rare and vulnerable fish—eating bird species have not been sufficiently studied or require updated information to assess the state of their populations and effective conservation. During the census of Pallas's Gull in the fairway of the Volga reservoirs in 2020–2022 [22,60], I suggested that reservoirs and fish farms with a locally high abundance of fish resources can play an important role in providing food and maintaining its population and spreading beyond the historical range. The answer to this question was recently obtained for Palearctic reservoirs, which turned out to be important in the modern distribution of the species [13]. However, sporadic and not synthesized observations in fish farms until recently added little clarity to the hypothesis formulated above.

In this analytical review, based on a previously tested methodological approach [13,22], an attempt was made for the first time to assess the role of Palearctic fish farms in the life of Pallas's Gull and its dispersal beyond the boundaries of the breeding range over the past ≈ 60 years. Collecting facts about the spatial distribution and number of fish farms with which these gulls interacted, and identifying the status of the species on the territory of a particular fish farm were the main objectives of the current study.

The data in this article represent the result of many years of observations by naturalists from around the world. The study revealed that fish farms play only a supporting role in maintaining the population and expanding the species' range. This complements the overall picture of the population status of Pallas's Gull in the Palearctic, and improves our understanding of its use of artificial bodies of water against the backdrop of a rapidly changing habitat. The review is addressed to (1) ornithologists involved in the study of spreading species and the conservation of rare bird species, (2) workers in the fishing industry, (3) specialists designing fishery bodies of water and (4) specialists of technical services developing repellents for ichthyophage birds. The proposed work may be useful in compiling an essay about the Pallas's Gull for national and regional Red Books, to identify further trends in changes in the distribution and abundance of the species.

2. Materials and Methods

2.1. Study area

This study used historical publications and recent data collected within the boundaries of the Palearctic zoogeographic region. I conducted field faunal observations mainly in Russia on the reservoirs of (1) the Upper Volga (1986–2024), mainly in the Yaroslavl region outside the breeding range of the Pallas's Gull, but rare registrations of dispersing individuals and (2) in regions where this species was relatively common [13,22]. At the same time, the bodies of water of the Kaluga, Kostroma, Ivanovo, Vologda, Tver, Novgorod regions and the Baltic Sea coast were examined (2020–2024), where potentially wandering Pallas's Gulls could be encountered. A short–term ornithological survey of carp, sturgeon and trout fish farms was carried out by the author on the bodies of water and reservoirs of the Upper Volga (1991–2021), Karelia (2023), Scandinavian (2023) and Kola Peninsulas (2023).

2.2. Material and research methods

The review is based on a compilation of relevant publications between the second half of the 20th century and the beginning of the 21st century (1960s–2020s) and long–term field observations of the author. In this study, reservoirs and fish farms

are considered as artificial bodies of water that have been impacted to a greater or lesser extent by human activity. The phrase "fish farm" was used in a narrow sense, meaning open ponds with an abundance of fish, to varying degrees available for predation or scavenging by fish–eating birds.

The search for historical thematic publications was carried out in Russian and English in the search engines Yandex, Google, Google Scholar, eLybrary. It was produced using the following keywords and phrases: черноголовый хохотун, рыбхоз, рыбное хозяйство, рыборазводный пруд, рыбоводный завод, рыбный пруд, аквакультура, fish pond, fish farm, aquaculture pond, fish hatchery, Great Black–headed Gull, Pallas's Gull, *Larus ichthyaetus*, *Ichthyaetus ichthyaetus*. More than 1100 publications were reviewed, where the required ornithological information was limited exclusively to the Palearctic region. Publications with records of Pallas's Gull in settling ponds were excluded from the search results and subsequent analysis, since in most published works the affiliation of settling ponds with fish farming or other industrial use was not identified. Ultimately, only those publications where Pallas's Gulls were indicated as interacting with the water body(s) of a particular fish farm were selected and analyzed. In such cases, I recorded (1) the name of the fish farm, (2) the size of the area used (km²), (3) the status of the species (breeding, non–breeding), (4) year(s) of observation, (5) country(s), (6) link(s) to the published source. The status of a species was determined from publications.

In order to visualize information and obtain additional parameters for data analysis, geographic (GPS) coordinates of the location of fish farms were also recorded (see Appendix). If the geographic coordinates of a particular fish farm were not published, then an additional search was made for the missing parameters on the Internet. In those cases (n = 18) when information about the location of a fish farm was not found even with the help of additional search efforts, the geographic coordinates of the location of a specific fish farm on the map were indicated approximately, with reference to the nearest settlement or geographic object indicated on the map (lake, river, wetland, etc.). This implied some error in the location of the fish farm. For a few small countries where the Pallas's Gull was found more than on the territory of one fish farm, but their geographic coordinates were not published, the coordinates of this country were indicated, and the fish farms of each specific country (Poland, Cyprus, Israel) were considered in total as one place of contact Pallas's Gulls with an unknown number of fish farms in each country. According to the above, there were 3 places of contact in Poland, Cyprus and Israel (1 place in each country). If the sizes of fish farms' bodies of water were not published or found through a special search on the Internet, they were excluded from the catalog of fish farms (**Table 1**) visited by Pallas's Gull.

Table 1. Catalog of fish farms in the Palearctic where Pallas's Gull (*Ichthyaetus ichthyaetus*) was recorded, 1974–2022.

№	Water body name	Area (km²)	Status	Year	Source
Russia					
1	Fish farm Filippovka	4.0	NBr	1996	[61]
2	Fish farm Pikhtovka	7.0	NBr	1999–2002	[61–64]
3	Fish farm Klinskiy	≈ 10.0	NBr	1993	[65]
4	Fish farm Lotoshinsky	≈ 15.0	NBr	2007–2019	[18]
5	Fish farm Biserovsky	8.55	NBr	2015–2020	[18]
6	Fish farm Kirya	3.1	NBr	2009	[66]
7	Karasevsky fish ponds	–	Br	1986	[26,27,67]
8	Fish farm Okunevsky	–	NBr	1990	[68]
9	Fish farm Para	20.0	NBr	2009	[69]
10	Fish farm Suskan	≈ 10.0	Br	Second half of the 20th century	[70] cited in: [49]
11	Fish ponds near the Biofabrika village	–	NBr	2004, 2005	[71,72]

Table 1 continued

№	Water body name	Area (km²)	Status	Year	Source
Russia					
12	Fish farm Uzinsky	–	NBr	1986	[73]
13	Fish farm Borisovsky	–	NBr	2012	[74]
14	Fish farm near the village of Nagolnoe	–	NBr	2008	[75,76]
15	Fish farm in the Don delta	10.5	NBr	1995–2011	[77]
16	Fish farm Novomaryevsky	–	+	1995–2003	[78]
17	Fish farm Voskhod (Neftekumsky)	–	+	1995–2003	[78]
18	Fish farm Plakseika	–	+	1995–2003	[78]
19	Fish ponds near the city of Cherkessk	–	+	1960–1980	[79]
20	Fish ponds at the mouth of the Samur River	1.06	NBr	1980–1989	[80]
21	Fish farm Stavropolsky	–	+	1995–2003	[78]
Russia–Kazakhstan					
22	Fish ponds of the Shybynda River	–	NBr	1992	[81]
Kazakhstan					
23	Fish hatchery Koszharsky	2.1	NBr	1982, 1983	[82]
Uzbekistan					
24	Fish farm Damashi	–	NBr	2022	[83]
25	Fish farm Pskentsky	–	NBr	2019	[84]
26	Fish farm of Andijan	–	NBr	2021	[85]
Kyrgyzstan					
27	Fish farm in the Chui valley	–	NBr	1985–2016	[16,86], [88] cited in: [89]
Latvia					
28	Nagli fish pond	20.0	NBr	1974	[14]
Belarus					
29	Fish farm Luban	12.76	NBr	2016	[90]
30	Fish farm Selets	25.0	NBr	2016	[91]
31	Fish farm Beloe	24.16	NBr	1998, 1999	[48,92,93]
32	Fish farm Sokolovo	5.61	NBr	2021	[94]
33	Fish farm Novoselki	9.58	NBr	2002	[95]
Poland					
34	Fish ponds of Poland	–	NBr	Late 20th, early 21st century	[14]
Czech Republic					
35	Říha fish pond near Skochovice village	0.34	NBr	2014	[17]
Ukraine					
36	Fish farm Pechenezhsky	10.0	Br?	1984	[96] cited in: [97]
37	Fish ponds near Tubiltsy village	–	NBr	1997, 1998	[98]
38	Fish farm Krasnooskolsky	–	NBr	1996	[99]
39	Fish farm of Gorodok	1.2	NBr	1985	[100]
40	Fish farm near the village Raygorodok	25.0	NBr	Second half of the 20th century	[101]
41	Fish farm near the village of Stanichno–Luganskoe	–	NBr	1992	[102]
Ukraine–Moldova					
42	Fish ponds near the village of Pavlovka	–	NBr	2021	[103]

Table 1 continued

№	Water body name	Area (km²)	Status	Year	Source
Serbia					
43	Kapetanski Rit fish farm	–	NBr	2008	[15]
Cyprus					
44	Fish ponds of Cyprus	–	NBr	Second half of the 20th century	[9]
Israel					
45	Open fish ponds of Israel	–	NBr	Second half of the 20th century	[30] cited in: [9]
Egypt					
46	Fish farm near El–Noras village	–	NBr	Early 21st century	[4]

Note: Br — breeding, Br? — breeding is expected, NBr — the species does not breed, "+" — the species was registered, but the status is not determined, "–" — no data. The numbering of fish farms in the leftmost column coincides with the numbering of fish farms in **Figure 2**.

The size of the vast expanses of fish farms used in this work on the map of Eurasia, where Pallas's Gull was recorded, and the linear distances between fish farms on the surface of the earth were calculated in the Google Earth Pro program. The figures were processed in Adobe Photoshop CC 2015.0.0 Portable Version (USA). Tables and graphs are made in the spreadsheet processor Microsoft Excel 2013 (USA). The data visualization is shown in **Figure 2**. The results of the search efforts and the systematization of relevant information are presented in Table 1 and in the Appendix.

Figure 2. Distribution of fish farms in the Palearctic where Pallas's Gull (*Ichtyaetus ichtyaetus*) has been recorded.

Note: red circle — breeding is established; black and red circle — breeding has not been established, but is assumed; yellow circle — breeding is not established; green circle — breeding status is unclear.

2.3. Research equipment

Field observations and area survey were carried out by the author on foot, as well as by vehicle, boat and ship transport. Visual observations were made using 8 × binoculars. A Garmin eTrex 30™ GPS recorder was used to record geographic coordinates. Digital images of the study object and its habitat were obtained using a hand–held Canon 60D digital camera fitted with Canon 70–200 mm zoom lens.

3. Results and Discussion

Since the 1960s, observations of interactions between Pallas's Gull and fish farms have increasingly become the subject of special research interest for ornithologists. This is evidenced by estimates of the number of publications on encounters of Pallas's Gulls on the territory of various fish farms at the beginning of the 21st century (37 publications). According to the author's calculations, it has at least more than doubled compared to the second half of the 20th century (16 publications). However, the number of documented fish farms visited by Pallas's Gull was low. For example, in Russia alone there are more than 3 thousand farms operating in the field of commercial aquaculture [104]. Against this background, by the beginning of 2024, at least only 22 (0.73%) places of contact of Pallas's Gulls with fish farm bodies of water were documented. Nevertheless, the collected material allows us to draw some conclusions about the number and geographical distribution of fish farms with which Pallas's Gull came into contact, and about the breeding status of the species on them.

3.1. Number and spatial distribution of fish farms with which the Pallas's Gull came into contact

Over the past ≈ 60 years (1960s – 2020s), at least 46 places have been identified where the Pallas's Gull came into contact with water bodies of Palearctic fish farms. In Europe, 35 (76.09%) such sites are known, although only 11 (23.91%) sites are known in Asia. The Pallas's Gull has been found in the waters of fish farms in 14 countries. At least 21 places have been identified in Russia, 6 places in Ukraine, 5 places in Belarus, 3 places in Uzbekistan, one place each on the border of Russia and Kazakhstan, on the border of Ukraine and Moldova, as well as in Kazakhstan, Kyrgyzstan, Latvia, the Czech Republic, Serbia and Egypt. In Poland, Israel and Cyprus, the Pallas's Gull visited fish farms, but their number in each country was > 1, and the specific number of places was not indicated in publications [9,14,30], as mentioned above. This is also true for at least 2 regions of Russia [8,35]. For comparison, we note that globally, Pallas's Gull was observed in 67 countries, and vagrant individuals were recorded in 26 countries [12].

In Europe, in 33 places, registrations of the species covered water bodies of fish farms of the Great European Plain (Russia, Poland, Latvia, Belarus, Ukraine and Moldova), one place was established in Central (Czech Republic) and South–Eastern Europe (Serbia). In the Asian part of the Palearctic, at least 3 places with a larger number of fish farms have been identified — in Western Asia they are indicated for Cyprus, Israel and the Sinai Peninsula in Egypt. In Central Asia, 6 places have been identified — on the border of Russia and Kazakhstan, as well as in Kazakhstan, Uzbekistan and Kyrgyzstan. One place each was recorded in the Southern Trans–Urals and Western Siberia.

The distribution range of fish farms visited by Pallas's Gull by latitude (N) was between 30 and 50 degrees. 93.48% of fish farms visited by birds were recorded at 40 (41.3%) and 50 (52.17%) parallels with a peak at 50 latitudes (**Figure 3**). It was at these parallels that the majority of registrations of the species in fish farms occurred, which may indicate their greatest attractiveness. Contacts with fish farms did not reach the 60th latitude of the taiga zone of Eurasia, which is completely unexplored by Pallas's Gull.

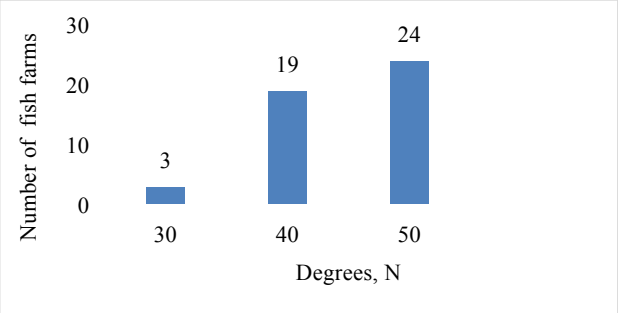

Figure 3. Distribution of the number of fish farms visited by Pallas's Gull (*Ichthyaetus ichthyaetus*) (x–axis) by latitude (y–axis).

Along with this, the range of distribution of fish farms visited by Pallas's Gull by longitude (E) was between 10 and 80 degrees. 73.9% of fish farms were located at 20–40 degrees longitude with a peak at 30 degrees longitude (**Figure 4**). Thus, the distribution of fish farms visited by Pallas's Gull in longitude was more than 2 times greater than that in latitude.

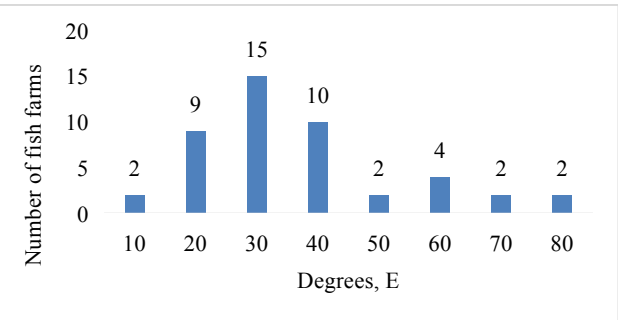

Figure 4. Distribution of the number of fish farms visited by Pallas's Gull (*Ichthyaetus ichthyaetus*) (x–axis) by longitude (y–axis).

The Říha fish pond near Skochovice village (Czech Republic) was the most western, the fish farm Filippovka (Russia) the most northern, the fish farm in the Chui valley (Kyrgyzstan) the most eastern, and the fish farm near El–Noras village (Egypt) the most southern, where the gulls did not breed. The distance between the northernmost (fish farm Filippovka) and southern (fish farm near El–Noras village) water bodies was 3376 km, and between the most western (Říha fish pond near Skochovice

village) and eastern (fish farm in the Chui valley) bodies of water was 4959 km. The total distribution area of fish ponds with which Pallas's Gull came into contact was 5144747 km².

The average area of fish farms visited by Pallas's Gull on documented occasions was 10.7 km² (n = 21). According to the author's calculations, for reservoirs it was 1186.7 km² (n = 53, [53]), which was more than 100 times greater than the area of fish farm bodies of water. Thus, the bodies of water of fish farms were negligibly small in comparison with the territories of reservoirs where Pallas's Gull was observed. We also note that the bodies of water of fish farms were visited by non–breeding individuals of different age classes, i.e., from < 1 year old to adult individuals (for example, [18,61]).

During numerous short–term expeditionary surveys, I did not find the Pallas's Gulls on the fish farms of the Upper Volga, Karelia, the Scandinavian and Kola Peninsulas, as well as on the bodies of water of the Baltic Sea coast. However, in the taiga zone of the European part of Russia, the most northern registrations of non–breeding individuals of this species were recorded in artificial bodies of water (the Rybinsk reservoir) at a latitude of 58°N [22]. At the same latitude, in the Filippovka fish farm of the Kirov region, a unique and most northern recording of Pallas's Gull was established among the bodies of water of fish farms in the taiga zone, where long–term ornithological observations were carried out [61]. Thus, at present only rare vagrant individuals can be found on the bodies of water of fish farms in the taiga zone. However, the share of fish farms visited by Pallas's Gull in the forest–steppe zone (43.48%) and the zone of broad–leaved and mixed forests (30.43%) forms the basis (73.91%) of the total range of fish farms in five natural zones with an optimum in the forest–steppe zone (**Figure 5**).

According to the results obtained, the highest concentration of recordings of Pallas's Gulls on the fish farm bodies of water was observed in the Western Palearctic. In Europe, the number of such places was 3 times higher than the corresponding places in Asia. At the same time, according to visual estimates, the density of fish farms visited by birds decreased from west to east, and the distance between the nearest fish farms increased in the same direction.

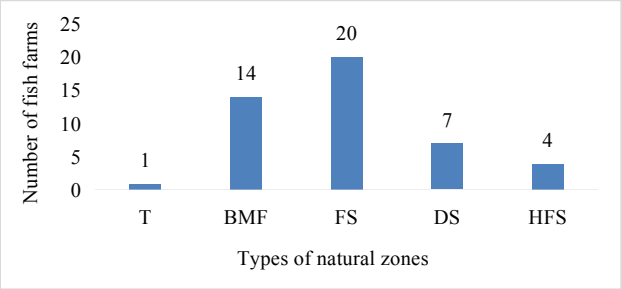

Figure 5. Quantitative distribution of fish farms visited by Pallas's Gull (*Ichthyaetus ichthyaetus*) across natural zones of Eurasia.

Note: T — taiga; BMF — broad–leaved and mixed forests; FS — forest–steppe; DS — deserts and semi–deserts; HFS— hard–leaved evergreen forests and shrubs.

The Karelia, the Scandinavian and Kola Peninsulas are outside the range of dispersion of this species to the north. Along with this, the Upper Volga region is located at the northern limit of the dispersion of non–breeding individuals [13,22]. Therefore, it is not surprising that there are no registrations of rare vagrant Pallas's Gulls in fish farm bodies of water in the above–mentioned regions. However, registrations are not excluded in the future.

The greatest extent of the northern limit of registrations of non–breeding individuals and rare breeding sites north of the breeding range of the species is located in Northern Eurasia, in Russia [22], where the total number of Pallas's Gulls, together with immature individuals, can reach and even slightly exceed 100,000 individuals [11]. The dispersion to the north appears to be the most widespread, and in this regard, the territory of Russia is of interest as a vast testing ground for the modern dispersal of the Pallas's Gull outside the historical range.

At the turn of the 20th and 21st centuries in the European part of the former USSR, the northern limit of the species' distribution was drawn to 47°N [105]. It is interesting that between the second half of the 20th century and 2021, at the 47th parallel and to the north, 25 (80.65%) places of contact of non–breeding Pallas's Gulls with fish farm bodies of water were known, and only 6 (19.35%) such places were identified south of the above border. Of these, north of the historical northern border of the species' dis-

tribution in the European part of the former USSR, breeding of these birds was observed only in the Suskan fish farm at 53°N [49,70], and in the Pechenezh fish farm at 50°N breeding was expected [96,97].

3.2. Status of the species in fish farm bodies of water

The Pallas's Gull bred on the territories of 2 fish farms in Russia (one place each in the European and Asian parts) in the latitude range between 53°N and 55°N – on the Karasevsky fish ponds [26,27,67] and on the Suskansky fish farm[49,70] . Presumable breeding was observed in Ukraine at the Pechenezh fish farm at 50°N [96,97]. However, in the above–mentioned places, these gulls did not form large colonies, breeding in one or several pairs [26,27,67,96,97]. Moreover, in known cases they bred in the fish farm bodies of water, the total area of which was at least 10 km². The optimum breeding grounds for Pallas's Gulls actually coincided with the peak number of fish farms at 50 latitudes. In 38 places, these gulls did not breed. They were observed in 5 places, but their local status was not indicated in publications.

Analysis of the facts did not reveal places of stable reproduction of the species with a high number of breeding pairs in the water bodies of the Palearctic. One gets the impression that the breeding of Pallas's Gulls on the fish farm bodies of water within the boundaries of the considered zoogeographical region is random. In addition, the success of reproduction in new breeding sites on the territories of fish farms is likely to be low. One way or another, the conclusion arises that fish farms cannot be considered as important places for the breeding of the species in the general range of not only artificial, but also natural bodies of water, where the anthropogenic influence is minimal.

3.3. Limitations, forecasts, prospects and conservation

3.3.1. Limitations

An analysis of thematic publications established the rarity of long–term detailed observations on the territories of a few fish farms, but revealed the opportunistic nature of ornithological observations on a much larger number of other fish farms. Faunal information dominated most of the publications used. The lack of targeted observations on the aspect under study did not allow significant progress in a deeper understanding of the relationship between Pallas's Gulls and the water bodies of fish farms. The limited accessibility of fish farms, especially privately owned ones, reduces the duration of observations, spatial coverage and the number of potentially interesting sighting sites where Pallas's Gull has been recorded or could be observed. However, the above limitations are not an insurmountable obstacle.

3.3.2. Forecasts

Taking into account the progress in the development of aquaculture and fish farming, in particular [1] at the beginning of the 21st century, and the increasing role of fish farms in the life of fish–eating birds, we can assume a slight increase in the number of registrations of Pallas's Gulls in the bodies of water of fish farms. In the foreseeable future, the expansion of the species to the north will most likely continue, but it will not be rapid or significant. In fish farms of the taiga zone north of 60 parallels, registration of the species will be unlikely, but possible. An increase in the number of registrations of non–breeding individuals in spring, summer and autumn can be expected on fish farm bodies of water of the 40th, but mainly of the 50th parallel of northern latitude. The bodies of water of some fish farms may be used by Pallas's Gull for breeding, but breeding will still be rare, sporadic and irregular. In this regard, in my opinion, the Suskansky fish farm, where long–term monitoring of avifauna is carried out [49], under favorable environmental conditions, may be a promising place for the breeding of this species in the future.

3.3.3. Research prospects

In the course of further monitoring in the territories of fish farms, it is useful to collect or continue collecting phenological data, data on the daily activity of Pallas's Gulls in the bodies of water of fish farms, to register seasonal variability in the number

of birds, to record the age composition of encountered individuals, feeding behavior and diet. Descriptions of the environmental conditions of those fish farms where Pallas's Gulls breed are also necessary. Publication of new and previously unpublished data on the Pallas's Gull in fisheries areas could be a valuable addition to existing knowledge.

Increasing public interest in citizen science can improve the scale of monitored sites, helping to improve patterns of species distribution and abundance [87]. When applied to the Pallas's Gull, citizen science can be useful to curators of regional biology programs in collecting relevant observations over large areas and at local scales. Planning and subsequent survey of a larger number of available fish farms during a specific field season in a specific geographical or administrative region will allow the collection of new valuable material. It is especially valuable if such work is organized over vast areas of the species' habitat. An important applied aspect is the study of fish farms as testing grounds for finding reasonable compromises between human interests and fish–eating predators.

3.3.4. Conservation

It was proposed to use gentle methods to scare away fish–eating birds from fish ponds, conduct educational work among fish farm workers and hunters, and educate the population about the need to protect the Pallas's Gull [11]. Before the start of the breeding season, centralized personal warning measures are advisable by distributing relevant information via the Internet to the management and employees of fish farms about the importance of protecting the species, especially where the Pallas's Gull was breeding or had the status of a summer resident. In places of former or potential breeding, as well as in places of concentration of non–breeding individuals on fish farm bodies of water, it is advisable to organize monitoring, seasonal rest zones or minimize human disturbance of birds in local areas of bodies of water, whenever possible.

4. Conclusions

The methodology used in this work identified 46 sites in the Palearctic between the 1960s and 2020s where fish farms with abundant fish resources were controlled by humans and attracted the Pallas's Gull. This indicator is negligible compared to the existing and increasing number of bodies of water in the aquaculture industry. The bodies of water of fish farms support non–breeding individuals — vagrants, visitors, summer or winter residents of different age classes. Breeding or probable breeding was established on 3 fish farms, and breeding on each specific fish farm occurred in one or more pairs. Stable, long–term breeding sites were not recorded on fish ponds. The ecological conditions of these fish farms limited the breeding opportunities of gulls, since fish ponds were not large in area compared to their natural aquatic habitats. Bodies of water of fish farms cannot be considered as important places for the reproduction of the species in the general range of water bodies with different anthropogenic loads. Increased chronic human activity in the bodies of water of fish farms, including direct persecution of birds, could increase the number of stressful situations for these fish–eating predators. The limited availability of food resources during the breeding season, the lack of suitable islands with breeding colonies of other gull species (usually large white–headed gulls) near which the Pallas's Gull nests, could also contribute to this. In fact, fish farms play a certain supporting role in the wintering areas of Pallas's Gulls. The hypothesis put forward at the beginning of this study about the possible important role of reservoirs and fish farms in the food supply and distribution of Pallas's Gulls beyond the historical range was not confirmed in studies of fish farms. Thus, the network of fish farms that existed previously and now plays a certain auxiliary, but far from decisive role in maintaining the population and the current multidirectional expansion of the species' range in the Palearctic.

Conflict of Interest

The author declares that there is no conflict of interest.

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References

[1] Aquaculture of Russia. [Internet]. 2024. [cited 2024 March 3]. Available from: http://aquacultura.org/. (In Russian)

[2] Martyshev, F., 1973. Pond fish farming. Vysshaya shkola: Russia. pp. 1–428. (In Russian)

[3] Mishchenko, A.L., 1983. The importance of fish ponds for the conservation of avifauna in the anthropogenic landscape of the Moscow region. Bulletin of the Moscow Society of Nature Testers. Biological department. 88(4), 15–25. (In Russian)

[4] Al–Rajhi, M.A., 2018. Using an eco–system for frightening fish–eating birds. Recent Advances in Environmental Science from the Euro–Mediterranean and Surrounding Regions; Proceedings of Euro–Mediterranean Conference for Environmental Integration (EMCEI–1); 2017; Tunisia. 449–453. DOI: https://doi.org/10.1007/978–3–319–70548–4_140

[5] Kandolo, A.P., Mabenga, B.M., Mambo, T.B., et al., 2019. Composition and Use Period of Bird Fauna in Fish Ponds in Kisangani City, Democratic Republic of the Congo. Agricultural and Biological Sciences Journal. 5(3), 115–126.

[6] Mawardha, F.S., Amir, J., Sugiyo, P.W.W., Fet al., 2021. Aves biodiversity in Wonorejo fish pond (Surabaya, Indonesia): the conservation status of endemic and migration aves. Ecology, Environment and Conservation. 27(2), 741–744.

[7] Mishchenko A.L., 1985. The importance of fish ponds for avifauna in an anthropogenic landscape (using the example of the Moscow region). Dissertation of a candidate of biological sciences. Moscow. pp. 1–231. (In Russian)

[8] Emelyanov, S.A., Dementiev, M.S., 2016. Ecological features of the formation of trematode diversity in fish–eating birds of the Central Ciscaucasia. Bulletin of the agrarian and industrial complex of Stavropol region. Ecology. 1(21), 221–224. (In Russian)

[9] Frost, R., Flint, P., 2001. The occurrence of Great Black–headed Gull *Larus ichtyaetus* in Cyprus. Sandgrouse. 23(2), 112–118.

[10] Sarychev, V.S., 2017. Birds of the Gryaznovsky fish farm. Lipetsk Ornithological Bulletin. 1, 58–70. (In Russian)

[11] Zubakin, V., 2021. Pallas's Gull Larus ichthyaetus (Pallas, 1773). In Red Data Book of the Russian Federation (Animals), 2nd edition. FGBU VNII Ekologia: Russia. pp. 761–763.

[12] Species factsheet: *Larus ichthyaetus*. [Internet]. BirdLife International; 2024. [cited 12 March 2024]. Available from: https://datazone.birdlife.org/species/factsheet/pallass–gull–larus–ichthyaetus

[13] Golubev, S.V., 2023. Distribution and Status of the Pallas's Gull *Ichthyaetus ichthyaetus* (Pallas, 1773) in the Reservoirs of the Palearctic: Review. Research in Ecology. 5(1), 23–34. DOI: https://doi.org/10.30564/re.v5i1.5691

[14] Lawicki, L., 2012. Great Black–headed Gull: Why is it still so rare in Northern and Western Europe. Birding World. 25(9), 380–389.

[15] Hulo, I., Horvat, F., 2008. New data on rare breeders and migrants birds in northern Bačka and Banat in the period from 2006 to 2008. Ciconia. 17, 62–64.

[16] Trotchenko, N.V., Kasybekov, E.Sh., 2012. Rare and endangered species of birds in the

Chui Valley water bodies. Search. Natural and Technical Sciences Series. 3, 51–56. (In Russian)

[17] Kadava, L., 2014. The second record of the Pallas's Gull (Larus ichthyaetus) in Eastern Bohemia. Panurus. 23, 87–91.

[18] Skachkov, S.A., Shvedko, M.A., 2022. New data on rare species of gulls in the Moscow region. Russian Journal of Ornithology. 31(2255), 5287–5302. (In Russian)

[19] Ostrovsky, O.A., Natykanets, V.V., 2023. Ornithofauna of the fish farm "Beloye" (Gomel region). Russian Journal of Ornithology. 32(2273), 581–615. (In Russian)

[20] Krivenko, V., Vinogradov, V., 2008. Birds of the Water Environment and Rhythms of Climate of the Northern Eurasia. Nauka: Russia. pp. 1–558. (In Russian)

[21] Rusanov, G.M., Gavrilov, N.N., Litvinov, K.V., 2014. The Island Maly Zhemchuzhny—ornithological pearl of the Northern Caspian. Astrakhan Bulletin of Environmental Education. 3(29), 67–75. (In Russian)

[22] Golubev, S., 2023. Status of the Pallas's Gull *Ichthyaetus ichthyaetus* during summer/autumn in the Fairway Volga–Kama Reservoirs (East European Plain) in Russia. Birds. 4(1), 46–60. DOI: https://doi.org/10.3390/birds4010004

[23] Borodin, O., 1994. Conspectus of the bird fauna of the Ulyanovsk region: A reference book. Filial MGU: Russia. pp. 1–96. (In Russian)

[24] Poslavsky, A.N., 1991. Brief reports about Pallas's Gull (Kzyl–Orda region). Rare birds and animals of Kazakhstan; Kazakhstan. 203. (In Russian)

[25] Brusyanin, P.E., Gashek, V.A., Zakharov, V.D., 2009. Preliminary results of the field season 2010 in the Chelyabinsk region. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia. 15, 31–33. (In Russian)

[26] Zakharov, V., 2006. Birds of the Southern Urals (species composition, distribution, numbers). Miass: Russia. pp. 1–228. (In Russian)

[27] Zakharov, V.D., 2015. To the nesting of the Pallas's Gull Larus ichthyaetus in the Chelyabinsk region. Russian Journal of Ornithology. 24(1190), 3328–3332. (In Russian)

[28] Debelo, P.V., Stepanov, A.S., Stepanova, I.A., Romanova, A.S., 2016. Some ecological and geographical features of the dynamics of the composition and number of waterfowl in the Eastern Orenburg region (KOTR RU–2017, OB–002). Bulletin of Orenburg State University. 10(198), 49–57. (In Russian)

[29] Generalov, S.E., 1989. Nesting of the Pallas's Gull in the Chelyabinsk region. Distribution and bird fauna of the Urals; Russia. pp. 10–11. (In Russian)

[30] Shirihai, H., 1996. The Birds of Israel. Academic Press: Great Britain. pp. 1–876.

[31] Bukreev, S.A., Chernobay, V.F., 2001. Volgograd Sarpa as a refugium of rare bird species. Current problems in the study and protection of birds of Eastern Europe and Northern Asia; Russia. pp. 116–118. (In Russian)

[32] Sarychev, V.S., 2011. Recordings of the Pallas's Gull Larus ichthyaetus in the Lipetsk region and the Central Chernozem region. Russian Journal of Ornithology. 20(623), 52–54. (In Russian)

[33] Chernobay, V.F., Bukreev, S.A., 2011. Technogenic reservoirs of the Volgograd Sarpa as a unique refugium of limnophilic birds. Bulletin of Mordovian University. 4, 295–298. (In Russian)

[34] Vlasov, A.A., Mironov, V.I., Vlasova, O.P., et al., 2012. Meetings of new and rare bird species in the Kursk region in the first decade of the XXI century. Monitoring of rare and vulnerable bird species in the Central Chernozem region; Russia. pp. 169–180. (In Russian)

[35] Lastukhin, A.A., 2016. Nesting of the Pallas's Gull Larus ichthyaetus and Caspian Gull Larus cachinnans in the mouth of the Kama. Russian Journal of Ornithology. 25(1364), 4416–4419. (In Russian)

[36] Belik, V.P., Gugueva, E.V., Makhmutov, R.Sh.,

2013. Rare bird species of Volgograd Sarpa. Bird conservation in Russia: problems and prospects; Russia. pp. 48–54. (In Russian)

[37] Barbazyuk, E.V., 2003. Gull birds of Lake Aik (Eastern Orenburg region). Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia; Russia. pp. 29–31. (In Russian)

[38] Tarasov, V.V., Zvigintsev, S.E., 2013. Additions to the bird fauna of the south of the Kurgan region. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia. 18, 185–196. (In Russian)

[39] Yagunov, M.G., Garms, O.Ya., 2013. Observations on the phenology of birds in the village of Volchno–Burlinskoye (Krutikhinsky district of the Altai Territory) in 2012 and 2013. Altai Zoological Journal. 7, 30–44. (In Russian)

[40] Reznichenko, S.M., 2020. Ornithofauna of Bayanaul National Park and adjacent territories. Russian Journal of Ornithology. 29(1886), 619–699. (In Russian)

[41] Barbazyuk, E.V., 2019. Pallas's Gull. Red Book of the Orenburg Region: rare and endangered species of animals, plants and mushrooms. MIR LLC: Russia. pp. 165–166. (In Russian)

[42] Barbazyuk, E.V., 2020. On the ecology of the Pallas's Gull, Gull–billed Tern and Caspian Tern in the Orenburg region. Issues of steppe studies 1(16), 37–51. (In Russian)
DOI: 10.24411/9999–006A–2020–10005

[43] Gordienko, N.S., 1991. Brief reports about the Pallas's Gull [Kustanay region]. Rare birds and animals of Kazakhstan; Kazakhstan. p. 201. (In Russian)

[44] Molodan, G.N., Bukreev, S.A., Dyakov, V.A., et al., 1991. New data on the distribution, abundance and biology of semi–aquatic non–passerine birds of the northern Azov region. Rare birds of the Black Sea region; Russia pp. 193–211. (In Russian)

[45] Shcherbakov, B.V., 2014. Mixed colony of Pallas's Gull Larus ichthyaetus, Caspian Gull L. cachinnans and Caspian Tern Hydroprogne caspia in the north–eastern part of Lake Zaisan. Russian Journal of Ornithology. 23(1078), 3836–3840. (In Russian)

[46] Lipkovich, A.D., 2016. Fish–eating birds of the Rostov region and aquaculture: conflict of interests and biodiversity conservation. Birds and agriculture; Russia. pp. 165–170. (In Russian)

[47] Spiridonov, S.N., Sarychev, V.S., 2017. Species structure of ornithocomplexes of fish breeding reservoirs in the forest–steppe zone. Bulletin of Moscow State Pedagogical University. Series: Natural Sciences. 4(28), 48–56. (In Russian)

[48] Ostrovsky, O.A., Natykanets, V.V., 2023. Ornithofauna of the fish farm "Beloye" (Gomel region). Russian Journal of Ornithology. 32(2273), 581–615. (In Russian)

[49] Zubchenko, O.N., Taranova, A.M., Lebedeva, G.P., 2004. Suskan as a reserve for semi–aquatic, waterfowl and other bird species in the Samara region. Samarskaya Luka: Bulletin. 15, 346–352. (In Russian)

[50] Important Bird Areas of Russia [Internet]. Russian Bird Conservation Union; 2023. [cited 2023 March 10]. Available from: www.rbcu.ru

[51] Vogrin, M., 1999. Breeding birds of Race ponds in NE Slovenia and their trends during 13 years. Ornis Svecica. 9, 127–132.

[52] Abramchuk, A.V., 2001. Ornithofauna of the fish farm "Stradoch" and its surroundings. Subbuteo. 4(1), 41–45. (In Russian)

[53] Delić, A., Grlica, I.D., 2003. Birds of the Končanica fish–ponds, Croatia. Natura Croatica. 12(2), 63–91.

[54] Menshikova, S.V., 2005. Waterfowl and semi–aquatic birds of the Ropshinsky ponds (Leningrad region). Russian Journal of Ornithology. 14(284), 291–309. (In Russian)

[55] Domashevsky, S.V., 2008. Ornithofauna of the fish–breeding complex "Krymok". Avifauna of Ukraine. 4, 49–58.

[56] Lapshin, A.S., Spiridonov, S.N., Rakhimov, I.I., 2010. Current state of the avifauna of fish–breeding reservoirs of the Republic of Mordovia. Bulletin of the Tatar State Humanitarian–

Pedagogical University. 2(20), 38–43. (In Russian)

[57] Reshetkova, N.P., 2013. To study the avifauna of the Gornoshchitsky fish hatchery (Ekaterinburg). Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia. 18, 73–93. (In Russian)

[58] Fundukchiev, S.E., 2018. Bird biodiversity in some fish ponds in south–eastern Uzbekistan. Scientific notes of the Crimean Engineering and Pedagogical University. Series: Biological Sciences. 1–2, 25–31. (In Russian)

[59] Wang, Y.–K., Li, C.–C., Huang, K.–Y., et al., 2020. Can Aquaculture Ponds Be Managed as Foraging Habitats for Overwintering Water Birds? An Experimental Approach. Sustainability. 12(24), 10335. DOI: https://doi.org/10.3390/su122410335

[60] Golubev, S.V., 2021. Pallas's Gull Larus ichthyaetus on the Volga River reservoirs in summer–autumn period. Proceedings of the International Symposium "Invasion of Alien Species in Holarctic. Borok–VI"; 11–15 October 2021; Borok, Russia. P. 81. (In Russian)

[61] Sotnikov, V., 2002. Birds of the Kirov region and adjacent territories. T. 1. Non–passerines. Part 2. OOO Triada–C: Russia. pp. 1–528. (In Russian)

[62] Zykin, A.V., Deryugin, A.A., 1999. New ornithological finds in Udmurtia. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia; Russia. *pp.* 95–96. (In Russian)

[63] Menshikov, A.G., 2019. Materials for the avifauna of the Udmurt Republic. Fauna of the Urals and Siberia. 2, 153–163. (In Russian) DOI: https://doi:10.24411/2411–0051–2019–10216

[64] Menshikov, A.G., Matantsev, V.A., Tyulkin, Yu.A., et al., 2000. New information on some bird species in Udmurtia. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia; Russia. *pp.* 131–132. (In Russian)

[65] Nikolaev, V.I., 1998. On encounters of rare migratory and vagrant bird species in the northwestern Moscow region. Rare species of birds of the Non–Chernozem center of Russia; Russia. pp. 111. (In Russian)

[66] Isakov, G.N., 2009. On the registration of some rare species on the territory of Chuvashia. Rare bird species of the Non–Chernozem center of Russia; Russia. pp. 265–266. (In Russian)

[67] Zakharov, V.D., 1989. Birds of the Chelyabinsk region. Kray Ra: Russia. pp. 1–75. (In Russian)

[68] Belyankin, A.F., 1999. Birds of the lowland part of the Kemerovo region. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia; Russia. *pp*. 14–43. (In Russian)

[69] Ivanchev, V.P., Fionina, E.A., Nikolaev, N.N., et al., 2013. Materials on new, rare and small bird species of the Ryazan region (based on the results of expeditionary and stationary studies in 2008–2009). Proceedings of the program "Birds of Moscow and Moscow Region". 9, 34–42. (In Russian)

[70] Gorelov, M.S., 1986. Protected natural areas and rare birds of the Kuibyshev region. Study of birds of the USSR, their protection and rational use: Abstracts of reports of the I Congress of the All–Union Ornithological Society and the IX All–Union Ornithological Conference; December 16–20, 1986; Leningrad. pp. 164–165. (In Russian)

[71] Klimova, I.G., Seselkina, O.S., Makhrova, O.K., et al., 2004. Additions to materials on the avifauna of the city of Orsk. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia; Russia. *pp.* 99–101. (In Russian)

[72] Makhrova, O.K., Makhrova, I.K., 2006. New data on birds of the city of Orsk. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia; Russia. pp. 156–158. (In Russian)

[73] Frolov, V.V., Anisimova, G.A., 2019. Pallas's Gull Larus ichtyaetus (Pallas, 1773). Red Book

of the Penza region. Animals. Vol. 2. 2nd ed.; JSC: Russia. pp. 197. (In Russian)

[74] Sokolov, A.Yu., 2015. On encounters of regionally rare bird species in the south of the Central Chernozem Region in 2000–2015. Russian Journal of Ornithology. 24(1226), 4473–4490. (In Russian)

[75] Sokolov, A.Yu., Shapovalov, A.S., 2009. Towards the distribution of rare bird species in the Belgorod region. Scientific bulletins. 3(58), 108–112. (In Russian)

[76] Sokolov, A.Yu., 2010. Avifauna of specially protected natural areas of the Belgorod region. Strepet. 8(1), 36–59. (In Russian)

[77] Belik, V.P., 2019. Autumn bird counts in the Don Delta. Russian Journal of Ornithology. 28(1737), 914–926. (In Russian)

[78] Klimashkin, O.V., 2003. Breeding ecology of the Pallas's Gull in the Central Ciscaucasia. Bulletin of the Stavropol State University. 34, 86–95. (In Russian)

[79] Karavaev, A.A., Khubiev, A.B., Kaziev, U.Z., 2009. Changes in the fauna and bird population of the Karachay–Cherkess Republic. News of universities. The North Caucasus region. Natural sciences. 2, 86–89. (In Russian)

[80] Butyev, V.T., Lebedeva, E.A., Kostin, A.B., 1990. Rare and little–studied bird species in fish ponds in the river delta. Samur (Dagestan Autonomous Soviet Socialist Republic). Rare, scarce and poorly studied birds of the North Caucasus; Russia. pp. 29–33. (In Russian)

[81] Davygora, A.V., 2013. Additions to the ornithological fauna of the Shybynda River valley and adjacent areas. Materials for the distribution of birds in the Urals, in the Cis–Urals and Western Siberia. 18, 27–40. (In Russian)

[82] Poslavsky, A.N., 2014. Pallas's Gull Larus ichthyaetus in the lower reaches of the Syrdarya and Turgay. Russian Journal of Ornithology. 23(992), 1273. (In Russian)

[83] Pallas's Gull Larus ichthyaetus (Pallas, 1773), 2024. [Internet] [cited 2024 March 3]. Available from: https://uzbekistan.birds.watch/v2photo.php?l=ru&s=002700026&n=2&t=186&p=0&sortby=1&sor=desc&saut=all&si=uzb. (In Russian)

[84] Pallas's Gull Larus ichthyaetus (Pallas, 1773), 2024. [Internet] [cited 2024 March 3]. Available from: https://uzbekistan.birds.watch/v2photo.php?l=ru&s=000700129&n=1&t=186&si=uzb. (In Russian)

[85] Pallas's Gull Larus ichthyaetus (Pallas, 1773), 2024. [Internet] [cited 2024 March 3]. Available from: https://uzbekistan.birds.watch/v2photo.php?l=ru&s=000800357&n=1&si=uzb. (In Russian)

[86] Fedyanina, T.F., 1990. Data on the abundance of some rare waterbirds of the Chui Valley. Rare and little–studied birds of Central Asia; Uzbekistan. p. 82. (In Russian)

[87] Passarotto, A., Costanzo, A., 2024. The pitfalls and potential of citizen science in ornithology. Avocetta. 48, 2024E001. DOI: https://doi.org/10.30456/AVO.2024E1

[88] Kasybekov, E., Kadyrova, B., Sagymbaev, S., et al., 2018. Illustrated guide to birds – representatives of the Charadriiformes order. Bishkek: Kyrgyzstan. pp. 1–104. (In Russian)

[89] Trotchenko, N.V., 2018. Waders, gulls and terns of the wetlands of the Chui Valley. Russian Journal of Ornithology. 27(1624), 2795–2806. (In Russian)

[90] Birds daily, 2024. [Internet] [cited 2024 May 15]. Available from: https://birdwatch.by/club200/10452. (In Belarusian)

[91] Birds daily, 2024. [Internet] [cited 2024 May 15]. Available from: https://birdwatch.by/news/10525. (In Belarusian)

[92] Vintchevski, A.E., Raty, L., De Smet, G., et al., I999. A new gull species for Belarus – Great Black–headed Cull (Larus ichthyaetus pall.). Subbuteo. 2, 49–50. (In Russian)

[93] Yakovets, N.N., Dmitrenok, M.G., 2000. New registration of Pallas's Gull (Larus ichthyaetus) in Belarus. Subbuteo. 3(1), 51–52. (In Russian)

[94] Demyanchik, V.T., Lukyanchik, M.A., Demyanchik, M.G., 2021. Birds of a fishery facility:

faunistic and economic aspects during the autumn migration season. Conference materials: Transborder regions in the context of global changes: modern challenges and development prospects; November 26–28, 2019; Gorno–Altaisk. Gorno–Altaisk State University. 136–142. (In Russian)

[95] Abramchuk, A.V., Abramchuk, S.V., Serbun, A.A., Bogdanovich, I.A., 2003. Autumn concentrations of waterbirds on the bodies of water of Brest Polesie. Berkut. 12(1–2), 128–142. (In Russian)

[96] Odukha, A.R., Chernikov, V.F., Dumenko, T.N., et al., 1986. On the ecology of waterbirds in the ponds of the Pechenezh fish farm in the Kharkov region. Bulletin of Kharkov University. 288, 87–88. (In Russian)

[97] Nadtochiy, A.S., Vergeles, Yu.I., 2003. New sightings of the Pallas's Gull in Kharkov region. Birds of the Seversky Donets Basin. 8, 115–116. (In Russian)

[98] Grishchenko, V.M., Loparev, S.O., Gavrilyuk, M.N., Yablonovska–Grischenko, E.D., 1998. Birds of the Red Book of Ukraine in the Kaniv reserve and its surroundings. Conservation business in Ukraine. 4(1), 70–74. (In Russian)

[99] Banik, M.V., Dzhamirzoev, G.S., 1996. Flights of the Pallas's Gull into the Kharkov region. Berkut. 5(2), 205–206. (In Russian)

[100] Bokotey, A.A., 1987. The first sighting of the Pallas's Gull in the western regions of the Ukrainian SSR. Ornitologiya. 22, 175–176. (In Russian)

[101] Pisarev, S.N., Sikorsky, I.A., Korsun, D.A., et al., 1994. O About new rare species of birds of the Pridontsovye, Donetsk region. Birds of the Seversky Donets basin. Kharkiv. 2, 10–11. (In Russian)

[102] Vetrov, V.V., Litvinenko S.P., 2015. Current state of gull birds Laridae in the Lugansk region. Russian Journal of Ornithology. 24(1183), 3144–3147. (In Russian)

[103] Arkhipov, A.M., 2021. New finds of rare and migratory species and subspecies of birds in the Kuchurgan estuary area in the Odessa region. Berkut. 30(2), 85–88. (In Russian)

[104] Aquaculture, 2024. [Internet] [cited 2024 March 3]. Available from: https://arktikfish.com/index.php/akvakultura–na–rekakh–prudakh–ozerakh–limanakh/prudovaya–akvakultura/922–funktsionalno–genet. (In Russian)

[105] Stepanyan, L., 2003. Synopsis of the ornithological fauna of Russia and adjacent territories (within the borders of the USSR as a historical region). Akademkniga: Russia. pp. 1–808. (In Russian)

Appendix

Geographical coordinates of registration sites for Pallas's Gulls (*Ichtyaetus ichtyaetus*) in fish farms in the Palearctic. Note: the fish farm numbers in the leftmost column coincide with the fish farm numbering in **Figure 2**; "*" – geographical coordinates of the location of the fish farm are indicated approximately.

№	Water body name	Country	Coordinates
1	Fish farm Filippovka	Russia	58°12' N, 50°25' E
2	Fish farm Pikhtovka	Russia	57°08' N, 54°10' E
3	Fish farm Klinskiy	Russia	56°21'59" N, 36°18'37" E
4	Fish farm Lotoshinsky	Russia	56°13'38" N, 35°59'11" E
5	Fish farm Biserovsky	Russia	55°47′32″ N, 38°7′14″ E
6	Fish farm Kirya	Russia	55°14'28" N, 46°25'7" E
7	Karasevsky fish ponds	Russia	55°8'56" N, 60°26'17" E
8	Fish farm Okunevsky	Russia	54°57'06'' N, 85°25'54'' E
9	Fish farm Para	Russia	53°48'43" N, 41°8'48" E
10	Fish farm Suskan	Russia	53°45'50" N, 49°15'13" E
11	Fish ponds near the Biofabrika village	Russia	52°59′13″ N, 35°58′57″ E
12	Fish farm Uzinsky	Russia	52°58′13″ N, 45°18′45″ E
13	Fish farm Borisovsky	Russia	50°33'12" N, 36°5'4" E
14	Fish farm near the village of Nagolnoe	Russia	49°58'08'' N, 38°59'29'' E *
15	Fish farm in the Don delta	Russia	47°11'39" N, 39°34'56" E
16	Fish farm Novomaryevsky	Russia	45°2′28″ N, 42°8′4″ E
17	Fish farm Voskhod (Neftekumsky)	Russia	44°59′49″ N, 44°44′58″ E *
18	Fish farm Plakseika	Russia	44°39'5" N, 44°3'1" E
19	Fish ponds near the city of Cherkessk	Russia	44°13'48" N, 42°2'21" E
20	Fish ponds at the mouth of the Samur River	Russia	41°53'54" N, 48°28'54" E *
21	Fish farm Stavropolsky	Russia	45°27′15" N, 41°40′03" E *
22	Fish ponds of the Shybynda River	Russia–Kazakhstan	50°34'18" N, 73°40'59" E
23	Fish hatchery Koszharsky	Kazakhstan	46°09′05″ N, 61°45′42″ E
24	Fish farm Damashi	Uzbekistan	41°20′26″ N, 69°05′33″ E *
25	Fish farm Pskentsky	Uzbekistan	40°53′54" N, 69°20′29" E *
26	Fish farm of Andijan	Uzbekistan	40°46′55″ N, 72°20′39″ E *
27	Fish farm in the Chui valley	Kyrgyzstan	50°18′5″ N, 87°39′38″ E *
28	Nagli fish pond	Latvia	56°41′5" N, 26°55′42" E *
29	Fish farm Luban	Belarus	52°50'54" N, 28°1'9" E
30	Fish farm Selets	Belarus	52°28′50″ N, 25°0′49″ E *
31	Fish farm Beloe	Belarus	52°18'0" N, 27°38'27" E
32	Fish farm Sokolovo	Belarus	52°11′16″ N, 24°3′36″ E
33	Fish farm Novoselki	Belarus	52°08′08″ N, 26°49′23″ E *
34	Fish ponds of Poland	Poland	52°00′ N, 20°00′ E *
35	Říha fish pond near Skochovice village	Czech Republic	50°14′ N, 15°25′ E
36	Fish farm Pechenezhsky	Ukraine	50°0′15″ N, 36°14′8″ E *
37	Fish ponds near Tubiltsy village	Ukraine	49°32′45″ N, 31°48′0″ E
38	Fish farm Krasnooskolsky	Ukraine	49°16'3" N, 37°35'48" E
39	Fish farm of Gorodok	Ukraine	49°09′49″ N, 26°35′02″ E

№	Water body name	Country	Coordinates
40	Fish farm near the village Raygorodok	Ukraine	48°54’19’’ N, 37°43′25″ E *
41	Fish farm near the village of Stanichno–Luganskoe	Ukraine	48°39′ N, 39°28′ E *
42	Fish ponds near the village of Pavlovka	Ukraine–Moldova	47°14′24″ N, 29°33′36″ E *
43	Kapetanski Rit fish farm	Serbia	46°05’28” N, 19°46’15” E
44	Fish ponds of Cyprus	Cyprus	35°00′ N, 33°00′ E *
45	Open fish ponds of Israel	Israel	31°30′ N, 34°45′ E *
46	Fish farm near El–Noras village	Egypt	30°34’14” N 32°16’54” E